

### Claims

- 5 1. Use of a neurturin product and/or a modulator/effector thereof for the manufacture of a medicament to stimulate and/or induce the differentiation of insulin producing cells from progenitor cells.
2. The use of claim 1, wherein the progenitor cells are stem cells.
- 10 3. The use of claim 1, wherein the stem cells are embryonic or somatic stem cells.
4. The use of any one of claims 1-3, wherein the stem cells are of  
15 mammalian origin, preferably of human origin, with the proviso that the use of human embryos is excluded.
5. The use of any one of claims 1-4, wherein the progenitor cells have been transfected with a pancreatic gene, particularly the Pax4 gene.
- 20 6. The use of a neurturin product and/or a modulator/effector thereof for the manufacture of a medicament to promote the protection, survival and/or regeneration of insulin producing cells.
- 25 7. The use of claim 6, wherein the insulin producing cells are beta-cells.
8. The use of claim 6 or 7, wherein the insulin producing cells are of mammalian origin, preferably of human origin.
- 30 9. The use of any one of claims 6-8, wherein the insulin producing cells have been transfected with a pancreatic gene, particularly the Pax4 gene.

10. The use of any one of claims 1-9 for the prevention or treatment of a disease going along with impaired beta-cell function.
- 5 11. The use of claim 10 for the treatment of beta-cell degeneration in patients suffering from diabetes type I, LADA, or progressed diabetes type II.
- 10 12. The use of claim 10 for the prevention of beta-cell degeneration in patients at risk to develop beta-cell degeneration, like for example but not limited to patients suffering from diabetes type I or II, or LADA in early stages.
- 15 13. The use of any one of claims 1-12, wherein a neurturin product or a modulator/effector thereof that influences the expression level or function of a neurturin product is administered to a patient
  - (i) as a pharmaceutical composition e.g. enterally, parenterally or topically directly to the pancreas,
  - (ii) via implantation of neurturin protein product expressing cells,
  - 20 and/or
  - (iii) via gene therapy.
- 25 14. The use of claim 13, wherein the neurturin product or modulator/effector thereof is administered in combination with another pharmaceutical composition useful to treat beta-cell degeneration, for example but not limited to hormones, growth factors, or immune modulating agents.
- 30 15. The use of any one of claims 1-14, wherein the neurturin product is a protein including purified natural, synthetic or recombinant neurturin and variants thereof.

16. The use of claim 15 wherein variants are selected from insertion, substitution, deletion variants and/or chemically modified derivatives, for example but not limited to hybrids of neurturin and other TGF-beta proteins preferably from the GDNF-family.

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17. The use of claim 15 or 16, wherein the neurturin product is selected from proteins or peptides substantially homologous to the human neurturin precursor protein having the amino acid sequence published as GenBank Accession Number NP\_004549 and/or to the mature neurturin protein product that results from the cleavage of the neurturin protein precursor published as GenBank Accession number NP\_004549.

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18. The use of any one of claims 1-17, wherein the neurturin product is a nucleic acid, e.g. RNA and/or DNA encoding a neurturin protein product.

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19. The use of any one of claims 1-18, wherein the neurturin product is selected from neurturin homodimers or heterodimers of a neurturin protein product and another protein, wherein the other protein preferably belongs to the GDNF-family or a nucleic acid coding therefor.

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20. The use of any one of claims 1-19, wherein the neurturin product is of mammalian origin, preferably human origin.

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21. The use of any one of claims 1-20, wherein the differentiation of progenitor, e.g. stem cells into insulin-producing cells in *vitro* comprises

- a) optionally activating one or more pancreatic genes in progenitor cells,
- b) optionally aggregating said cells to form embryoid bodies,
- c) cultivating said cells or embryoid bodies in specific differentiation media containing neurturin protein product and

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d) identifying and optionally selecting insulin-producing cells.

22. The use of claim 21, wherein the neurturin-treated insulin producing cells are

- 5 (i) capable of a response to glucose and/or  
(ii) capable of expressing glucagon.

10 23. The use of any one of claims 21-22, wherein the neurturin-treated insulin producing cells are capable of normalizing blood glucose levels after transplantation into mice.

24. The use of any one of claims 1-23, wherein an effective amount of in vitro neurturin-treated cells are transplanted to a patient in need.

15 25. The use of any one of claims 1-24, comprising a stimulation of neurturin expression,  
wherein cells from a patient in need that have been modified to produce and secrete a neurturin protein product in vitro are re-implanted into the patient and/or  
20 wherein cells of a patient in need are modified to produce and secrete a neurturin protein product in vivo.

25 26. The use of any one of claims 1-25 in combination with at least one further other pharmaceutical agent.

27. The use of claim 26 in combination with at least one further pharmaceutical agent suitable for the treatment or prevention of pancreatic diseases and/or obesity and/or metabolic syndrome.

30 28. The use of claim 27 in combination with at least one further pharmaceutical agent suitable for stimulating and/or inducing the differentiation of insulin producing cells from progenitor cells.

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29. The use of claim 26 in combination with at least one further pharmaceutical agent which has an immunosuppressive activity.

5 30. A method for differentiating or regenerating cells into functional pancreatic cells, the method comprising: (a) cultivating cells capable of being differentiated or regenerated into pancreatic cells in the presence of an effective amount of neurturin in vitro (b) allowing the cells to develop, to differentiate and/or to regenerate at least one pancreatic function; and (c) optionally preparing an effective amount of the  
10 differentiated or regenerated pancreatic cells for transplantation into a patient in need thereof.

15 31. The method of claim 30, wherein the patient in need is a human individual.

32. The method of claim 30 or 31, wherein the patient in need has (a) functionally impaired, (b) reduced numbers and/or (c) functionally impaired and reduced numbers of pancreatic cells.

20 33. The method of any one of claims 30-32, wherein said patient in need is a type I diabetic patient or type II diabetic patient or LADA patient.

34. The method of any one of claims 30-33, wherein the pancreatic cells are insulin-producing cells.

25 35. The method of any one of claims 30-34, wherein the pancreatic cells are beta-cells of the pancreatic islets.

30 36. The method of any one of claims 30-35, wherein the cells in step (a) are selected from embryonic stem cells, adult stem cells, or somatic stem cells.

37. The method of any one of claims 31-36, wherein the cells in step (a)

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are of mammalian origin, preferably human origin, with the proviso that the use of human embryos is excluded.

- 5 38. The method of any one of claims 30-37, wherein neurturin is added at concentrations between 1 ng/ml and 500 ng/ml, preferably between 10 and 100 ng/ml, more preferably at about 50 ng/ml.
- 10 39. The method of any one of claims 30-38, wherein the at least one pancreatic function is selected from insulin production in response to glucose and expression of glucagon.
- 15 40. A method for differentiating or regenerating cells into functional pancreatic cells, the method comprising: preparing an effective amount of a neurturin product or of cells capable of expressing a neurturin product for administration to a patient in need thereof.
41. The method of claim 40, wherein the neurturin product is a neurturin protein product.
- 20 42. The method of of claim 40, wherein the neurturin product is a nucleic acid encoding a neurturin protein product.
- 25 43. The method of claim 40, wherein cells have been modified to produce and secrete a neurturin protein product and are prepared for transplantation into a suitable location in the patient.
44. A cell preparation comprising neurturin-treated functional pancreatic cells obtainable by the method of any one of claims 30-39.
- 30 45. A cell preparation comprising a neurturin product expressing cells obtainable by the method of any one of claims 30-43.

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46. The preparation of claim 44 or 45, which is a pharmaceutical composition.
- 5 47. The preparation of any one of claims 44-46 for the treatment or prevention of pancreatic diseases, particularly diabetes.
48. The preparation of any one of claims 44-47 for administration by transplantation or for use in a medical device.
- 10 49. The preparation of any one of claims 44-48, which contains pharmaceutically acceptable carriers, diluents, and/or additives.
50. The preparation of any one of claims 44-49, which is a diagnostic composition.
- 15 51. The preparation of any one of claims 44-50, which is a therapeutic composition.
52. The preparation of any one of claims 44-51 for the manufacture of an agent for the regeneration of pancreatic tissues or cells, particularly pancreatic beta cells.
- 20 53. The preparation of any one of claims 44-52 for application in vivo.
- 25 54. The preparation of any one of claims 44-53 for application in vitro.
55. A method for identifying and/or characterizing compounds capable of modulating the differentiation or regeneration of cells into functional pancreatic, particularly insulin-producing cells comprising:
- 30 contacting a compound to be tested with cells under conditions wherein the cells are capable of being differentiated or regenerated into functional pancreatic cells in the presence of neurturin and determining the effect of the compound on the differentiation process.

56. The method of claim 55 comprising transfecting the cells with a DNA construct containing a reporter gene under regulatory control of a gene involved in beta-cell differentiation, contacting said transfected cells with a compound to be tested and determining the activity of the reporter gene.
57. The method of claim 54 or 55 comprising contacting embryoid bodies which are cultivated in a differentiation medium enhancing beta-cell differentiation with a compound to be tested and determining differentiation into insulin-producing cells.
58. A method for identifying and/or characterizing compounds capable of modulating the differentiation or regeneration of cells into functional pancreatic, particularly insulin-producing cells comprising:  
contacting a compound to be tested with cells under conditions wherein the cells are capable of being differentiated or regenerated into functional pancreatic cells and determining the effect of the compound on the expression of neurturin.
59. Use of a preparation of neurturin expressing cells for the treatment and prevention of diabetes.
60. The use of claim 59 for inducing the regeneration of pancreatic cells.
61. The use of claim 60, wherein pancreatic cells are beta-cells of the islets.
62. Use of a preparation of neurturin-treated cells for the treatment and/or prevention of diabetes.
63. The use of claim 62 wherein the cells are differentiated progenitor cells capable of insulin production.